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CONTAINMENT CELLS PUMPING TEST REPORT WAUKEGAN HARBOR REMEDIAL ACTION WAUKEGAN, ILLINOIS

Prepared for:

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1.0 INTRODUCTION

The pumping test activity was added to the scope of work for the Waukegan Harbor Remedial Action in 1993. The scope of work was developed over the Spring and Summer of 1993 in response to initial observations taken on the West Containment Cell at Outboard Marine Corporation's (OMC's) Waukegan Harbor Facility (see Figure 1). The pumping test analysis was proposed as a mechanism to determine that the three containment cells were designed and constructed to meet OMC's purpose. OMC's purpose is to reasonably maintain the hydraulic head inside the containment cells lower than outside the containment cell water level using the water treatment equipment designed and supplied by Canonie Environmental Services Corp. (Canonie). The obligations of OMC for operation of the three containment cells are set forth in Section 4.0 of the Operation and Maintenance Plan (O&M Plan) (Appendix VII) to the Consent Decree with the U.S. Environmental Protection Agency (EPA) (Appendix A).

In 1987 and 1988, OMC negotiated a settlement with EPA for the implementation of a remedial action for the Waukegan Harbor Superfund Site compliant with an amended Record of Decision from 1984. The remedial action included the construction of three containment cells by the installation of a soil-bentonite slurry wall through approximately 30 feet of fine to medium sand and tying into a clay till formation known locally as the Chicago Hardpan. The containment cells were, in turn, covered with a 60-mil high-density polyethylene (HDPE) liner and soil cover to prevent the infiltration of rainwater into the cells. In addition, the obligations of OMC under the agreement with EPA included the commitment to pump ground water from within each of the three containment cells to maintain an inward gradient (flow of water from outside the containment cell into the containment cell) at all times. The three containment cells proposed in the agreement with the EPA are known as the East Containment, West Containment, and Slip No. 3 Containment. These containment cell locations are shown on Figure 1.

During negotiations with the EPA in 1987, the issue of steady-state pumping rate from the three containments was raised as a concern related to the size of water treatment facilities and discharge rates to be expected from the containment cells, based on a conceptual assessment of conditions (see Figure 2) likely to be encountered from three flow components, namely:

- Flow through the soil-bentonite slurry walls;
- Flow from a confined bedrock aquifer upwards through the clay till;
- Flow around the bottom of the soil-bentonite slurry walls embedded three feet into the clay till.

Based on calculations, an inflow rate of approximately 500 gallons per day was projected as the refill rate with a two-foot difference in water elevation between the inside and outside of the containment cell (Appendix B).

During the final design activities in 1989, additional data was collected to determine the reasonableness of the assumptions made in the Appendix B conceptual calculation. The data included the determination of the actual head difference between the confined limestone aquifer and the surficial water table aquifer, and the vertical and horizontal permeability of the clay till formation. These results indicated that the upward gradient from the bedrock aquifer was less than the 20 feet assumed in the conceptual Appendix B calculation. The data also indicated that the permeability was less than the 10^{-7} cm/sec assumed for the clay till in the Appendix B calculation. Both of these factors would substantially reduce the flow of water from the bedrock aquifer upward into the containment cells. Overall, the final design results indicated that the flow through the soil-bentonite slurry wall and under the key into the clay till should predominate the inflow to the containment cells.

Based on the measured horizontal and vertical permeabilities in the upper 10 feet of the till surface, the final design was based on a minimum 3-foot deep key of the soil-bentonite slurry wall into the clay till. The 3-foot key, in combination with the approximate order of magnitude difference between vertical and horizontal permeability, would be effective in limiting the flow around the base of the soil-bentonite slurry wall.

In late 1992 and early 1993, as construction on the East and West Containment Cells concluded, concerns began to occur because of the lag time recorded at Piezometer P-12 during pumping of the West Containment Cell. During site preparation, the West Containment Cell water level was lowered to enable the deposition of select sediments from Slip No. 3 and thermal desorption activities in the West Containment Cell area. During West Containment Cell dewatering, Piezometer P-12 located near the northeast corner of the West Containment Cell lagged behind the other three piezometers in the West Containment Cell as the water level was lowered. The response of Piezometer P-12 led to concerns on the part of OMC and the Waukegan Harbor Trust as to the adequacy of design and construction of the West Containment Cell and therefore, the construction of the other cells. Because of these concerns, Canonie and OMC reached an agreement in the Spring and Summer of 1993 to perform a systematic and programmed pumping test at each of the three containment cells as a part of OMC's accepting the remedial action work by Canonie. The results of the pumping tests completed in 1993 and 1994 for the West and East Containment Cells and in 1994 and 1995 for Slip No. 3 are reported in Section 3.0 of this report. The results of both the East Containment Cell pumping test and West Containment Cell pumping test have been previously reported to OMC on July 27, 1994 and December 22, 1994, respectively. The earlier reports are not inclusive of the Slip No. 3 pumping test results and does not constitute Canonie's final conclusion as to the adequacy of the design and construction of the containment cells.

1.1 Summary

The three cells were pumped from 2-1/2 to 5-1/2 months to a specified drawdown of 6 to 8 feet (see Figures 3, 4, and 5). After reaching a 6- to 8-foot drawdown, a steady pumping rate was established by throttling back on the pumps to maintain a constant drawdown level. The pumping rate (as determined by the plant flow meter readings during steady-state pumping) to obtain a constant drawdown was 4.8 gpm for the East Containment, 2.6 gpm for the West Containment, and 2.1 gpm for Slip

No. 3 Containment. Within the accuracies of this analysis, the difference in pumping rates are approximately equal to the areal differences between the three containment cells as shown in Table 1.

The ground water recoveries were measured approximately daily at the East Containment Cell and West Containment Cell to the end of 1994. Recoveries for Slip No. 3 were measured daily until approximately April 1995. Based on the continuous measured recoveries and quarterly measurements taken thereafter, a standard recovery curve versus time on semi-log paper is presented in Figures 6, 7, and 8. The recovery curve shows that all three containments begin at a similar recovery rate, and that after approximately 50 to 70 days of recovery, both the West Containment Cell and the Slip No. 3 Containment Cell show a marked increase in recovery rate that is nearly identical, and is nearly twice the initial recovery rate.

The pumping test results indicated that the steady-state inflows at containment cell drawdowns of 6 to 8 feet produces inflow from all sources that is directly proportional to the difference in size of the three containments. In addition, the recovery response of the three containments indicate that the West Containment and Slip No. 3 contain a larger proportion of soil with a low specific yield than the East Containment. Because of the lower specific yield soil, less water is produced overall per volume of containment and the recovery rate is much more rapid since there is less available pore space to refill with water.

The steady-state pumping results are not adequate to indicate the actual amount of leakage from any individual source into the containment cells. The four primary sources of recharge to the containment cell during a steady rate pumping are:

1. Leakage through the soil-bentonite slurry wall;

2. Leakage through the clay till around the bottom key of the soil-bentonite slurry wall;

3. Upward flow from the bedrock aquifer through the clay till and into the containment;

4. Draining water from soils within containment due to the lowering of the water table inside the containment cell.

Based on the pumping tests, the frequency of pumping required to maintain a depressed water level in the containment cells is quantifiable. The West Containment Cell and Slip No. 3, will require pumping approximately every year, and the East Containment Cell will require pumping approximately every four years. Based on a proposed schedule as shown on Figure 9, the containment cell water level will be controlled using the single, up to 15 gpm portable water treatment plant, in a rotation that involves pumping the West Containment and Slip No. 3 Containment approximately four months and the East Containment one month per year.

The results of the pumping test indicate that containment cells are designed and constructed in a manner that meets the intended purposes under the Consent Decree between OMC and EPA for the operation and maintenance of a continuous inward gradient. In addition, the equipment provided for extracting and treating the water from within the containment cells is capable of reasonably maintaining the hydraulic head inside the cells below the outside water table aquifer level.

2.0 HYDROGEOLOGIC CONDITIONS AT THE SITE

The generalized soil profile (Figure 2) at the site consists of 20 to 30 feet of fine to medium sand. The sand is underlain by a layer of till (Chicago Hardpan) ranging in thickness of 75 to 85 feet. Under the till is the Silurian dolomite bedrock (bedrock). The ground surface at the site is sloping from the west to the east in the direction of Lake Michigan with elevations on the west side of approximately 585 and on the east side of approximately 583 prior to sloping down into the beach area next to Lake Michigan. The water table aquifer water level is only one to two feet below ground surface.

2.1 Upper Aquifer and Lake Michigan

The first layer of soil at the site is fine to medium sand (upper aquifer) with permeabilities ranging between 1 x 10^{-2} cm/sec to 3 x 10^{-2} cm/sec. The sand is hydraulically connected to Lake Michigan to the east. The upper aquifer is recharged from the surface from rainfall and snow melt, and is an unconfined aquifer discharging into Lake Michigan. Ground water elevations in the shallow aquifer ranging from 583 on the west side of the West Containment Cell to Elevation 582 on the east side of the East Containment Cell (Figure 2). The water level in Lake Michigan is at approximately Elevation 580.

The North Ditch is located on the north side of the site and is fully connected to Lake Michigan. Surface runoff and stormwater from buildings in the area are discharged into the North Ditch. The North Ditch has an influence on the ground water levels, especially in the northern portion of the site, and depending on the condition of the mouth of the ditch where the ditch enters into Lake Michigan, ground water levels change in direct proportion to the water level in the North Ditch. If during a storm the mouth of the ditch becomes plugged with sand, the water level in the North Ditch will increase and ultimately create a higher ground water level in the area of the East and West Containment Cells. Ground water in the upper aquifer, which is in an unconfined condition, is hydraulically connected to Lake Michigan and therefore, ground water levels at the site are directly proportionate to the water level in Lake Michigan.

2.2 Confined Aquifer

The second aquifer at the site is the confined aquifer in bedrock, which is separated from the upper aquifer by a layer of the till 75 to 85 feet thick. The bedrock aquifer is directly recharged by surface water from the Des Plaines River. The bedrock aquifer is under confined conditions and discharges into Lake Michigan at elevations below normal lake level.

The bedrock aquifer yields water primarily from fractures and openings rather than from voids between individual grains as in sand of the upper aquifer. Because of surface recharge west of the site, piezometric pressure or ground water levels in the rock aquifer decreases from the west to the east in the direction of Lake Michigan. The ground water level in the rock aquifer at the site at the west end of the West Containment Cell is approximately at Elevation 587, which is two feet above existing ground surface, and at the east side of the East Containment Cell is approximately at Elevation 580, which is more or less equal to the Lake Michigan water levels.

Generally speaking, there is upflow from the rock aquifer through the till into the shallow or upper aquifer in the area of the West Containment Cell and very minimal, if any, upflow in the area of the East Containment Cell.

2.3 Chicago Hardpan (Wedron Formation)

Chicago Hardpan (till) at the site consists of mainly silty clay with traces of fine to coarse sand with occasional cobbles and/or boulders and systems of seams to pockets and thin layers of silt or silty sand. The till is of the Wisconsinan Stage. During an investigation for containment cell design, Canonie performed permeability tests in the upper part of the till layer at the site. The permeability of the first 5 to 10 feet of the till are ranging from 4×10^{-8} cm/sec to 8×10^{-7} cm/sec. The till is approximately 75 feet thick at the west end of the site in the area west of the West Containment Cell, and is about 85 feet thick on the east side of East Containment Cell. The top of the till is sloping across the site approximately from Elevation 565 on the west to 554 on the east. Below the till, the bedrock formation is sloping also from the west to the east from approximately Elevation 488 on the west side to Elevation 470 on the east side of the site.

3.0 RESULTS OF PUMPING TEST

The containment cell pumping portion of the tests were conducted in late 1993 and late 1994 with recovery measurements going on through June 1995. The pumping part of the test for the East Containment Cell was completed in late 1993, for the West Containment Cell in the summer of 1994, and for the Slip No. 3 Containment Cell in early 1995 (see Figures 3, 4, and 5). In all three cases, the pumping test was conducted until drawdown was six to eight feet below the water level outside the containment cell. At the completion of the pumping or drawdown phase of the pumping test, the pumping rate at the pumping well was adjusted to produce a constant flow without changing the water level for at least three weeks. In the case of the West Containment Cell, the constant pumping rate was maintained for an extended period of five weeks. At the completion of the constant pumping phase, the pumping wells were turned off and recovery was monitored on approximately a daily basis through the end of 1994 at which time the Slip No. 3 pumping test was completed. Since the termination of daily water level monitoring, the recovery rates have been monitored on a quarterly basis as required by the O&M Plan.

3.1 Pumping test Results

3.1.1 Drawdown Response

The pumping test results are shown on Figures 3, 4, and 5 for the West Containment Cell, East Containment Cell, and Slip No. 3 Containment Cell, respectively. Both the East and West Containment Cells were pumped to a drawdown of approximately six feet below the outside water level prior to establishing a steady-state flow. The Slip No. 3 Containment Cell was pumped to a drawdown of approximately eight feet below outside water level before establishing a steady-state flow. The time required to reach the desired drawdown range from as little as 2-1/2 months at Slip No. 3 to as much as 4-1/2 months for the West Containment Cell. The time required to drawdown each cell six feet below the outside water level is shorter than the time calculated in the design for the containment cells. The difference results from the reduced drainage that is experienced in the actual containment cells where the actual water available is only 10 to 20 percent of the total volume, not the 30 percent assumed in the design. The calculation was based on the ready access of air to replace the draining water. When air cannot get in to replace the drainage water, less water is released and a continual slowed drainage results. This drainage impact is equatable to the difficulty one would experience in trying to draw water from a straw in a pop bottle with the pop bottle cap on. Although the containments are not a perfectly closed system (air can get in some place), they are sufficiently sealed to induce a suction limiting response to drainage as is evidenced by the barometric results measured and reported in Section 3.3 and evidenced by the responses of Piezometer P-1 in the Slip No. 3 containment and P-12 in the West Containment.

As shown on Figures 4 and 5, Piezometers P-12 and P-1 show higher water levels than the other piezometers in their respective West Cell and Slip No. 3 containments. Both of these piezometers are located in the apex of an acute angle (angle of less than 90 degrees). When a piezometer is located in an acute angle of a sealed containment where very little air or no air can enter to displace the draining water, the combined effect of the acute angle plus the lack of air to displace the draining water causes the water to be retained in that corner. This is due to suction forces in the fine sands of the containment area and induces a higher water level in comparison to the rest of the containment at both Piezometer P-1 of Slip No. 3 and P-12 of the West Containment Cell.

3.1.2 Steady-State Pumping Rate Response

Once each containment reached a drawdown of six to eight feet, the pumping rate was adjusted downward, if necessary, by restricting the output of the pumping well. The pumping was then continued for at least three weeks. In the case of the West Containment, however, constant rate pumping was continued for eight weeks.

The continuous pumping rate necessary to maintain a constant drawdown level was 2.6, 2.1, and 4.8 gpm for the West Containment Cell, Slip No. 3 Cell, and East Containment Cell, respectively. These pumping rates are a measurement of four major seepage components. Those components are:

1. Inflow through the soil-bentonite slurry wall due to the difference in elevation (drawdown) between the inside and outside of the slurry wall;

2. The inflow of water around the soil-bentonite slurry wall key in the clay till;

3. The inflow of water upward from the bedrock aquifer in the containment cell;

4. Seepage of drainage water from the partially dewatered zone between the starting inside water level and the water level at steady-state drawdown pumping level.

The relative proportions of these four components contributing to the flow required to maintain a constant drawdown, is not calculatable from any data determined during the pumping test.

Pumping rates do, however, indicate a relationship between the flow rate necessary to maintain a constant drawdown level and the areal size of each containment. This comparison is shown in Table 1 and indicates that the ratio of steady-state pumping rate to containment cell area is approximately 0.9 for all three cells. This indicates that the constant leakage rate is the same for each cell regardless of the source of the water.

3.1.3 Recovery Response

The recovery data are shown on Figures 3, 4, and 5 for each of the three cells, respectively. The recovery results are also shown on Figures 6, 7, and 8 in a semi-log time format as is normally used in the assessment of a pumping test recovery. Figures 6, 7, and 8 indicate that the recovery rate for all three cells is identical for the first 50 to 70 days of recovery. At 50 to 70 days into the recovery cycle, however, the recovery rate of the West Containment Cell and the Slip No. 3 Containment Cell increase, whereas the East Containment Cell seems to recover at the original rate established by the first 50 to 70 days of recovery.

The recovery of the containment cells is based on the dewatered void volume available for water to reenter. This void volume is defined as the specific yield and is less than the porosity of the soil. In a fully dewatered system, air enters the void space replacing the water. However, some water remains behind (specific retention) due to the suction or capillary effects between soil grains. The quantity of water remaining behind is directly related to the grain size of the soil with finer grained soils retaining a higher percentage of the water. For a typical fine sand, the specific yield will be approximately 10 to 20 percent, and the porosity 40 percent. For a silt, the specific yield is 3 to 5 percent, and the porosity 45 percent (Reference - Dewatering and Groundwater Control for Deep Excavations, Departments of the Army, the Navy, and the Airforce, April 1971).

The responses observed from the three pumping tests are directly related to soil types in the three cells. The East Containment Cell contains no organic silt backfill and is composed predominantly of a fine to medium sand. Specific yield is fairly uniform and the recovery rate as observed is fairly uniform. The West Containment Cell and Slip No. 3 Containment Cell, on the other hand, both contain substantial quantities of organic silt backfill. The organic silt backfill is found at higher elevations within the cell and does not have as high a specific yield. Therefore, as the cells begin to refill, the dewatered areas in the fine sand which have similar characteristics to those materials in the East Containment Cell backfill with water first, giving both the West Cell and Slip No. 3 Cell a recovery response very similar to the East Cell for the first 50 to 70 days. After 50 to 70 days, however, the remaining void space is in the siltier soils which have a lower specific yield. These soils refill quicker and cause the water leve rise to be faster.

The recovery results do indicate an actual rate of recovery and may be used to determine the frequency of pumping required to maintain an inward gradient. Based on the response at the West Containment and at Slip No. 3, the West Containment and Slip No. 3 Containment will require pumping for approximately 3 to 4 months every 12 to 18 months. The East Containment, because of the more uniform nature of the material and the higher specific yield of that material, will require pumping for three to four months only once every four years.

3.2 Water Treatment Results

During the three pumping tests, water samples were taken at the influent and effluent of the Category 5 water treatment system as required by the O&M Plan. All of the effluent results were less than the 1 part per billion (ppb) discharge limit required for PCBs under the O&M Plan. Water samples at the influent of the water treatment plant were taken on a weekly basis throughout all three pumping tests for the East Cell, West Cell, and Slip No. 3 Cell, and are shown in Table 2. The influent results indicate that with the exception of one result at 1.5 ppb, the water within the East Containment Cell meets the 1.0 ppb discharge criteria without treatment throughout the pumping cycle. The results, with the exception of one result at 2.0 ppb, also indicate that the influent water to the treatment system from the West Containment Cell meets the discharge requirements for the last 6-1/2 months of the pumping test. Results from the Slip No. 3 Cell indicate a requirement for treatment even after completion of the pumping test. Overall, these results indicate that the PCBs remaining within the containments are not being transported with the water at a level above the discharge limit.

3.3 Barometric Pressure Results

During each pumping test, at least one piezometer inside the containment cell was monitored on a continuous basis for the impact of barometric pressure changes. The results of the East and West Containment Cells are shown on Figures 10 and 11. The data from Slip No. 3 cell was lost due to an equipment failure during the downloading of the data. The results indicate that the piezometers inside the containment cell show rapid responses to changes in atmospheric pressure. This indicates that there is very little or no air interchange between the void space inside the containment cell and the outside atmosphere. The results confirm that the containments are acting as sealed units with very little inflow or movement of air across the barrier.

4.0 CONCLUSION

As discussed in Section 3.0, the leakage into each containment cell is composed of three predominant factors:

1. Leakage through the soil-bentonite slurry wall;

2. Leakage under the key of the soil-bentonite slurry wall;

3. Leakage upwards from the confined bedrock aquifer.

However, because the top of each containment is sealed with an impermeable HDPE liner, the downward drainage of water during a pumping event is restricted because air cannot enter the void space to replace water. The pumping rate, as measured in the pumping test, reflects both the three leakage factors and the downward drainage of water. It is, therefore, impossible to determine an exact leakage rate. It is possible, though, to conclude that the rate of pumping required to maintain a constant drawdown level in each containment is approximately proportional to the areal size of the containment.

The recovery rates measured as a part of the pumping tests on the three containments indicate the rate at which the water level inside the containment will recover from a six- to eight-foot drawdown event. This rate of recovery is based on the specific yield characteristics of the soils in the containments. The West Containment and Slip No. 3 Containment exhibit similar characteristics reflecting the high percentage of lower specific yield silts found in the two containments. The East Containment recovers at a much slower rate, indicative of the higher specific yield fine sand content of the East Containment Cell soils. The recovery rates do provide an adequate measure of the frequency of pumping required to maintain a lowered hydraulic head in all three containments.

Based on the pumping test results, the Slip No. 3 and West Containment Cells will require pumping approximately once every 12 months. The East Containment Cell will require pumping once every four years. Figure 9 shows a proposed pumping schedule to maintain a drawdown at all three containments that is based on a nine-month pumping period and not pumping during the Winter months of December, January, and February.

The pumping test results indicate that the containments are designed and constructed, and the water treatment plant is adequately sized to meet the intended purpose of the containments.

TABLES

TABLE 1

RATIOS OF PUMPING RATE TO AREA OF CELLS

Containment Cell	Area "A" (acre)	Pumping Rate "Q" (gpm)	Ratio Q/A
East	5.4	4.8	0.9
West	3.2	2.6	0.8
Slip No. 3	2.0	2.1	1.0

TABLE 2

INFLUENT PCB CONCENTRATIONS (PPB)
CATEGORY 5 AND 7 WATER TREATMENT PLANTS
WAUKEGAN HARBOR REMEDIAL ACTION

Date	West Cell	Slip No. 3 Cell	East Cell	
	Category 5	Category 5	Category 5	Category 7
7/28/93	--	--	1.0	--
8/6/93	--	--	<1.0	--
8/10/93	--	--	<1.0	--
8/16/93	--	--	--	<1.0
8/24/93	--	--	<1.0	<1.0
8/30/93	--	--	<1.0	<1.0
9/7/93	7.0	--	--	<1.0
9/13/93	--	--	--	<1.0
9/16/93	48.0	--	--	--
9/20/93	5.0	--	--	<1.0
9/28/93	4.0	--	--	<1.0
10/4/93	2.0	--	--	<1.0
10/11/93		--	<1.0	<1.0
10/18/93		--	<1.0	<1.0
10/25/93		--	<1.0	<1.0
11/1/93		--	<1.0	<1.0
11/8/93		--	<1.0	<1.0
11/15/93		--	1.5	<1.0
11/22/93	2.0	--	--	<1.0
11/29/93	11.0	--	--	<1.0
12/6/93	22.0	--	--	<1.0
12/13/93	7.0	--	--	<1.0
12/20/93	1.0	--	--	<1.0
12/27/93	1.0	--	--	--
1/3/94	1.0	--	--	--
1/10/94	1.0	--	--	--
1/17/94	<1.0	--	--	--
1/26/94	<1.0	--	--	--
1/31/94	<1.0	--	--	--
2/7/94	<1.0	--	--	--
2/14/93	<1.0	--	--	--
2/21/94	<1.0	--	--	--
2/28/94	<1.0	--	--	--
3/7/94	<1.0	--	--	--
3/15/94	<1.0	--	--	--
3/21/94	<1.0	--	--	--
3/28/94	<1.0	--	--	--
4/4/94	<1.0	--	--	--
4/11/94	<1.0	--	--	--
4/21/94	<1.0	--	--	--
4/25/94	<1.0	--	--	--
5/2/94	<1.0	--	--	--
5/9/94	<1.0	--	--	--

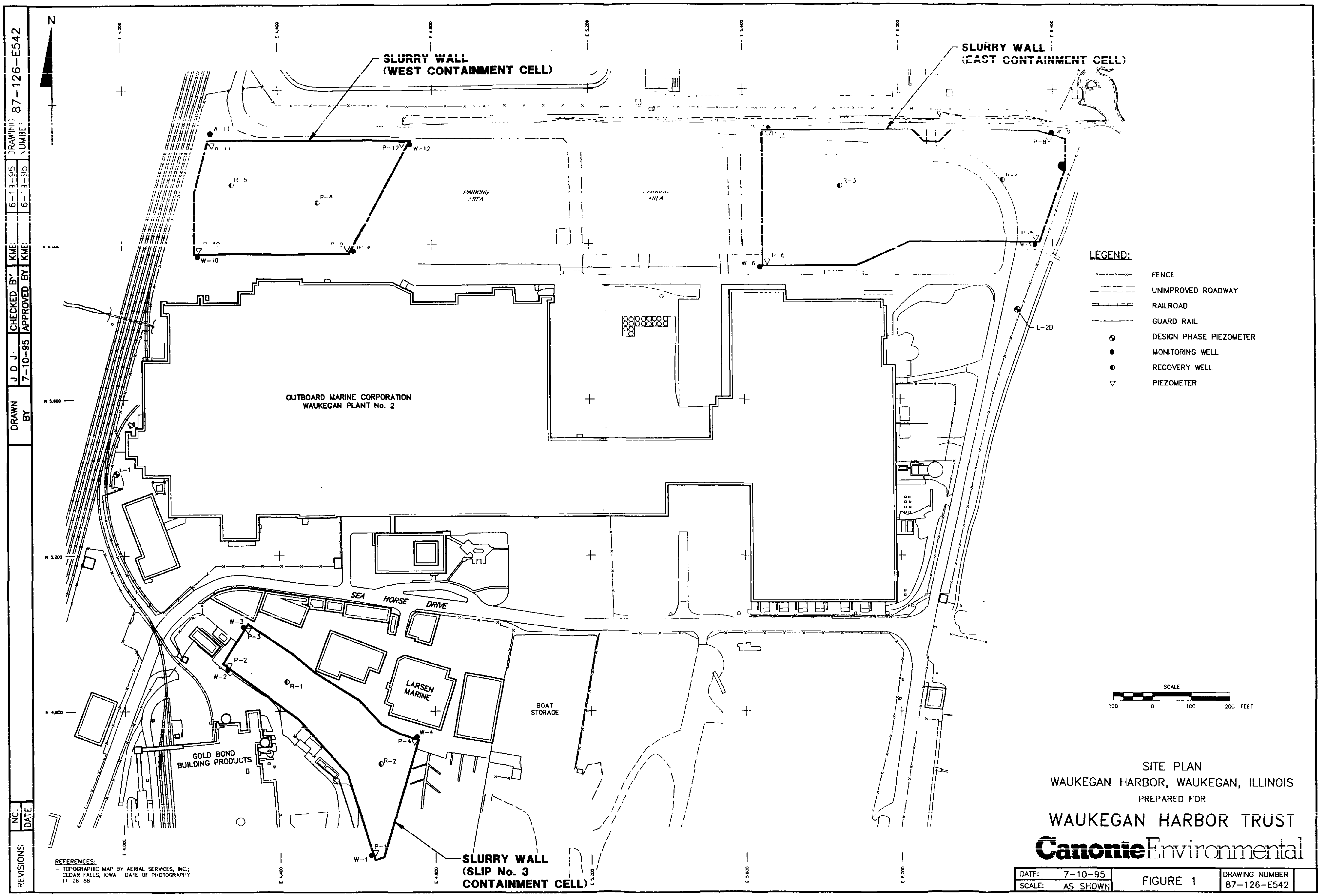
TABLE 2

INFLUENT PCB CONCENTRATIONS (PPB)
CATEGORY 5 AND 7 WATER TREATMENT PLANTS
WAUKEGAN HARBOR REMEDIAL ACTION

Date	West Cell Category 5	Slip No. 3 Cell Category 5	East Cell Category 5	East Cell Category 7
5/17/94	<1.0	--	--	--
5/23/94	<1.0	--	--	--
5/31/94	<1.0	--	--	--
6/6/94	<1.0	--	--	--
6/13/94	<1.0	--	--	--
6/20/94	<1.0	--	--	--
6/27/94	<1.0	--	--	--
7/5/94	2.0	--	--	--
7/12/94	<1.0	--	--	--
8/25/94		4.0	--	--
9/1/94		<1.0	--	--
9/7/94		11.0	--	--
10/20/94		6.0	--	--
10/27/94		8.0	--	--
11/3/94		6.0	--	--
11/10/94		14.0	--	--
11/16/94		11.0	--	--
11/21/94		7.0	--	--
11/30/94		8.0	--	--
12/8/94		13.0	--	--
12/15/94		13.0	--	--
12/29/94		10.0	--	--
12/22/94		6.7	--	--
1/5/95		10.0	--	--

Note: All effluent PCB concentrations were <1.0 ppb.

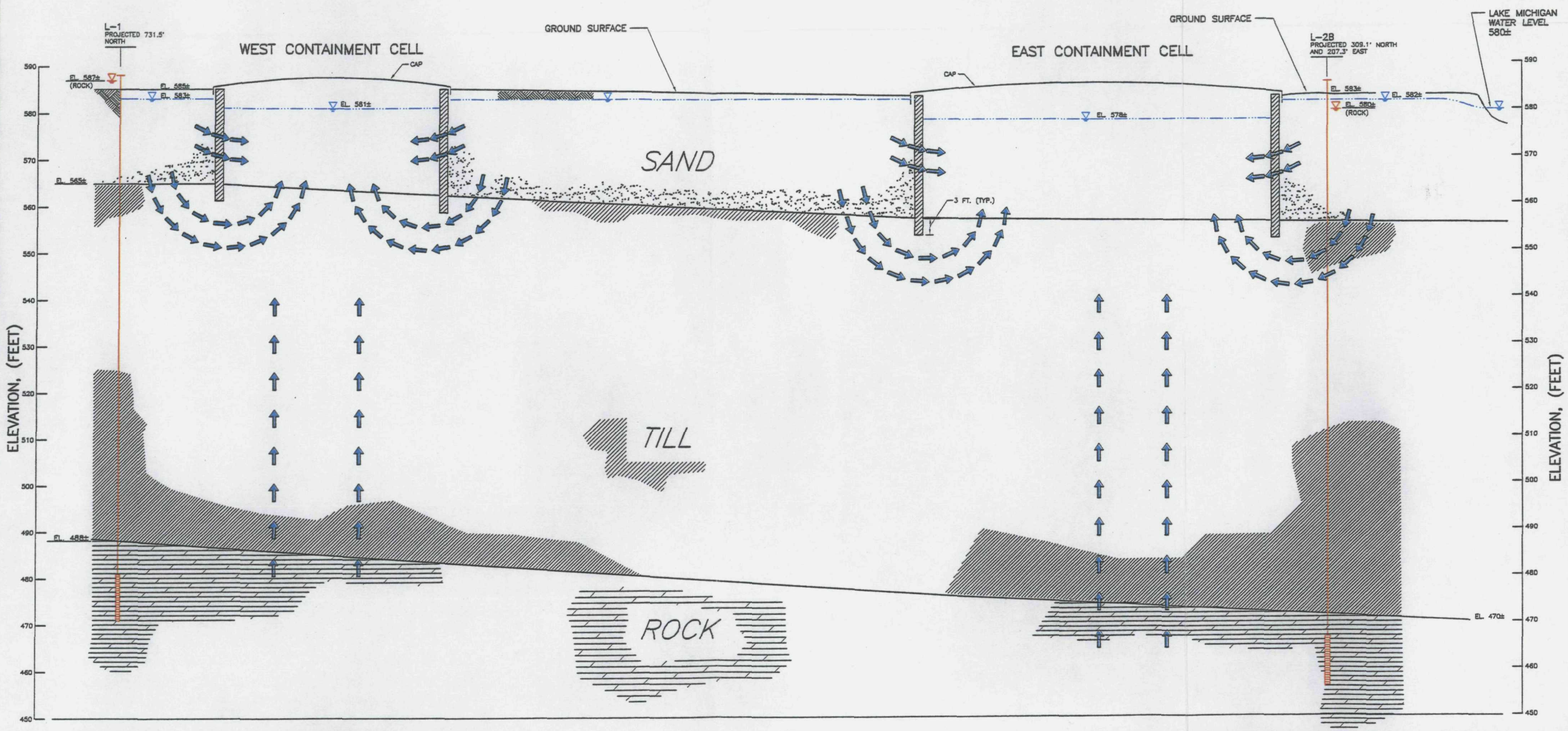
FIGURES

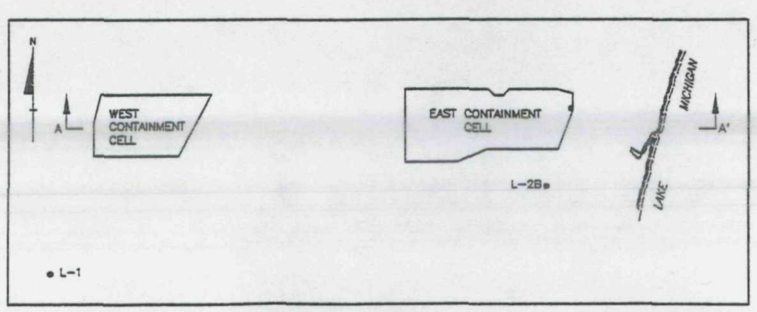


SITE PLAN
WAUKEGAN HARBOR, WAUKEGAN, ILLINOIS
PREPARED FOR
WAUKEGAN HARBOR TRUST

Canonie Environmental

DATE: 7-10-95	FIGURE 1	DRAWING NUMBER 87-126-E542
SCALE: AS SHOWN		





KEY MAP
NOT TO SCALE

SECTION A–A'
WEST AND EAST CONTAINMENT CELLS
(LOOKING NORTH)

HORIZONTAL SCALE
100 0 100 200 FEET

VERTICAL SCALE
10 0 10 20 FEET

GENERALIZED PROFILE
WAUKEGAN HARBOR, WAUKEGAN, ILLINOIS
PREPARED FOR
WAUKEGAN HARBOR TRUST

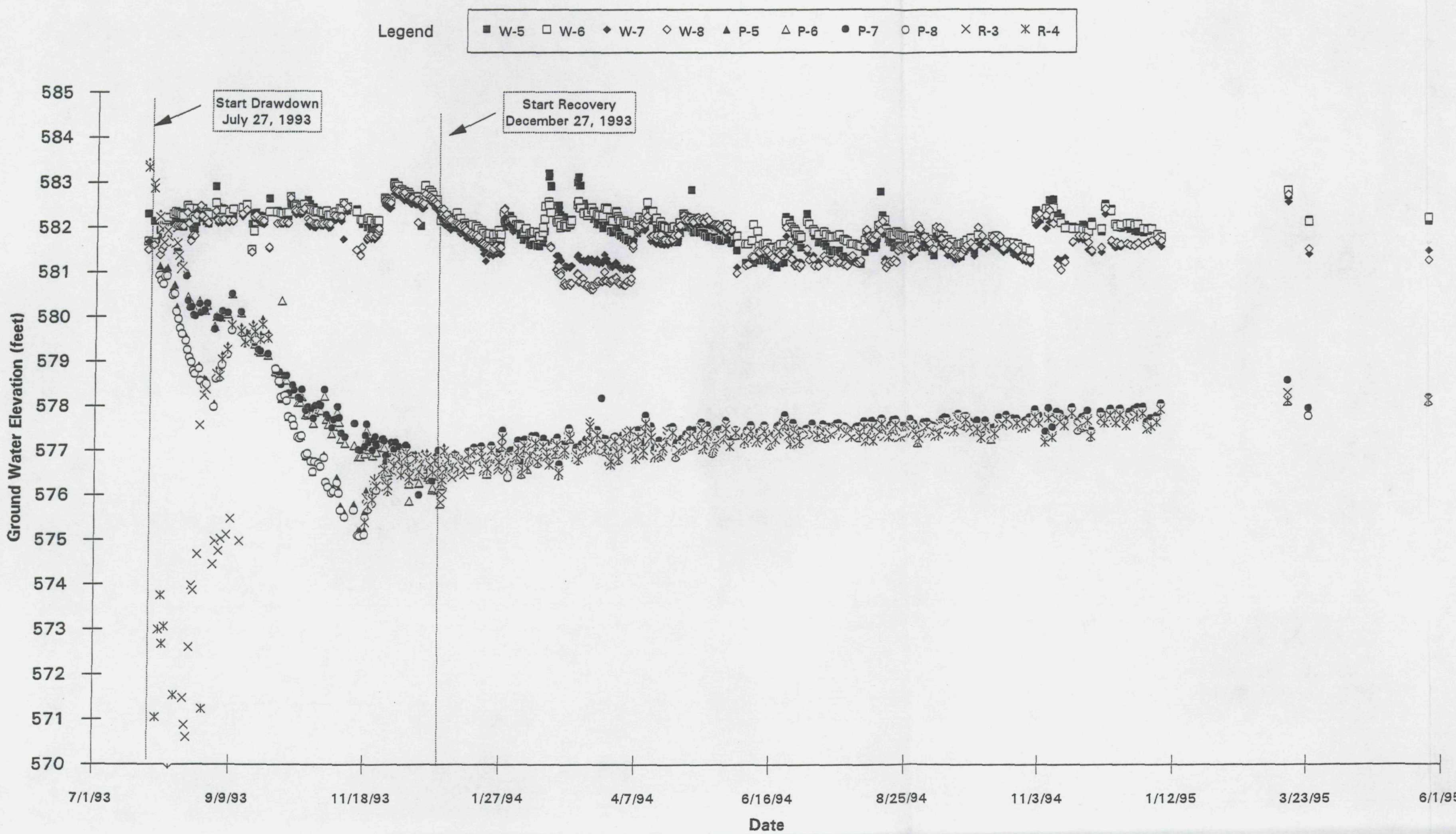
Canonie Environmental

DATE: 7-6-95	FIGURE 2	DRAWING NUMBER 87-126-E541
SCALE: AS SHOWN		

DRAWING NUMBER 87-126-E541

DRAWN BY	WWB	7-7-95	CHECKED BY	APPROVED BY

REVISIONS | NO. | DATE



KEY PLAN

NOT TO SCALE

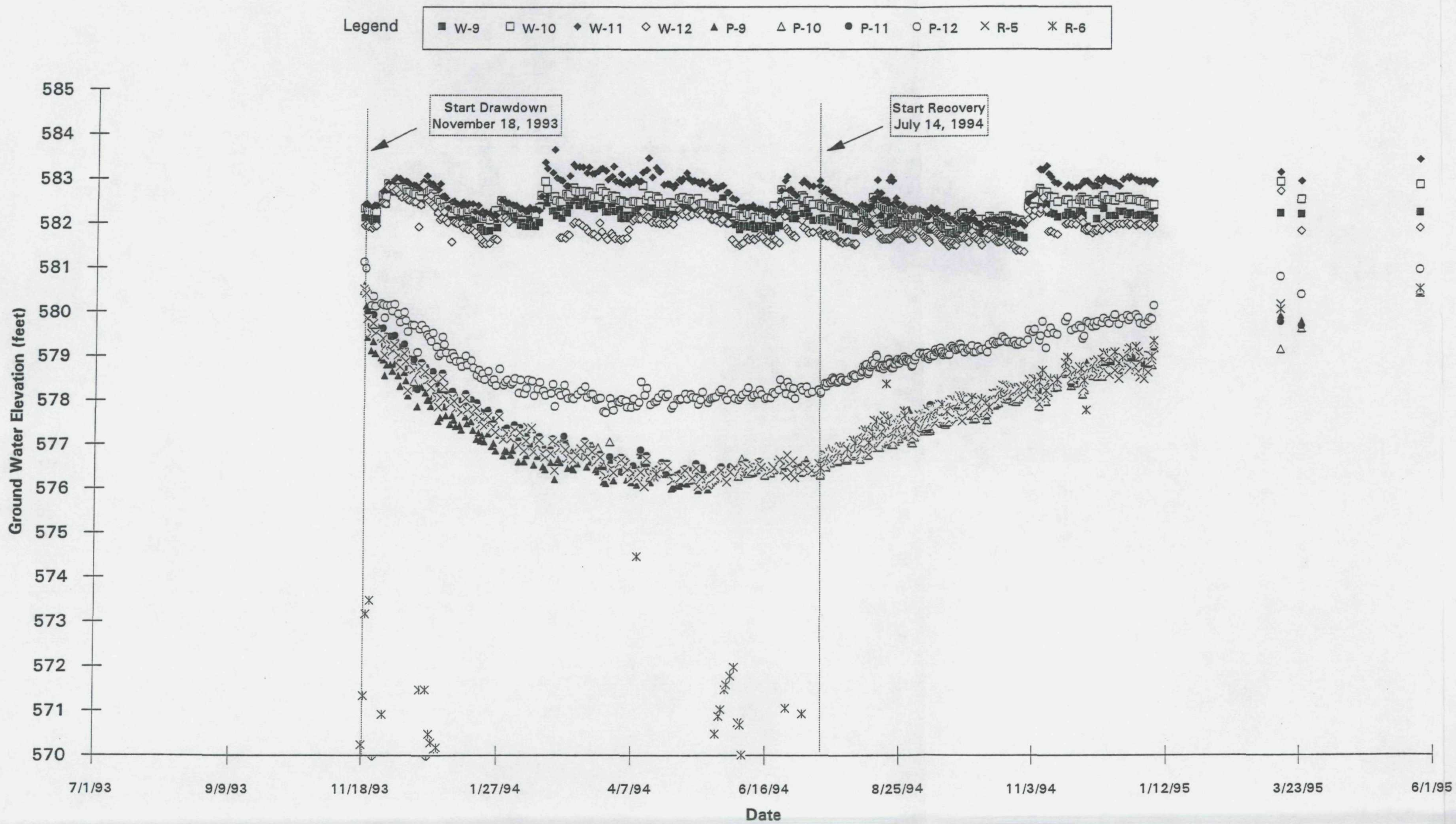
PUMPING TEST
EAST CONTAINMENT CELL
GROUND WATER ELEVATION vs. TIME
JULY 27, 1993 THROUGH JUNE 1, 1995
WAUKEGAN HARBOR, WAUKEGAN, ILLINOIS

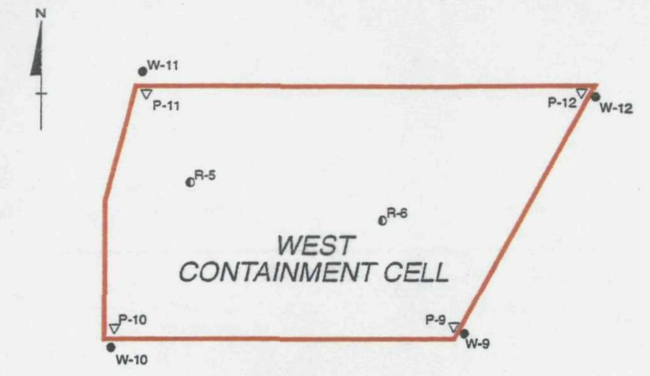
PREPARED FOR

WAUKEGAN HARBOR TRUST

Canonie Environmental

FIGURE 3





KEY PLAN

NOT TO SCALE

PUMPING TEST
WEST CONTAINMENT CELL
GROUND WATER ELEVATION vs. TIME
NOVEMBER 18, 1993 THROUGH JUNE 1, 1995
WAUKEGAN HARBOR, WAUKEGAN, ILLINOIS

PREPARED FOR

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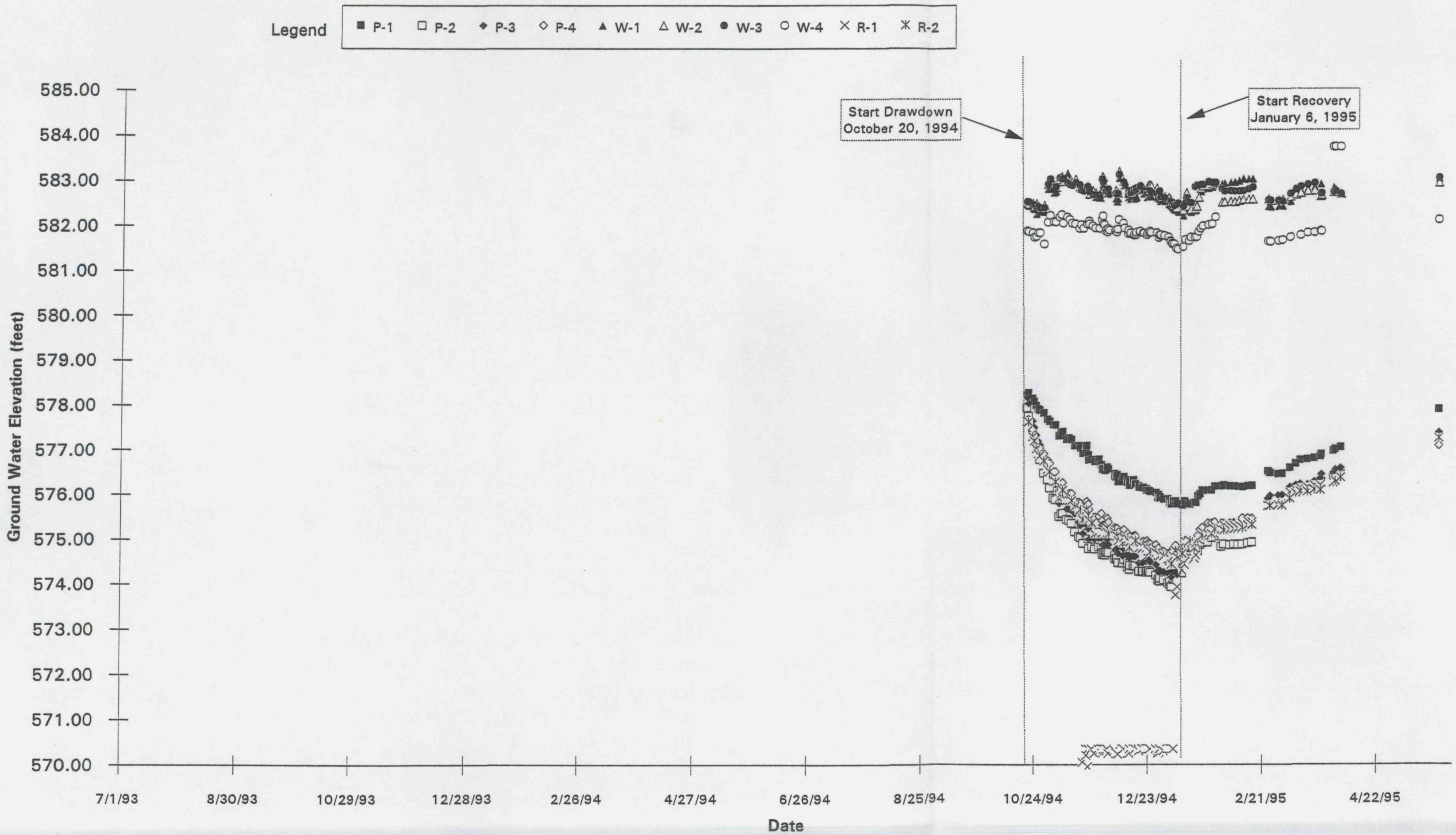
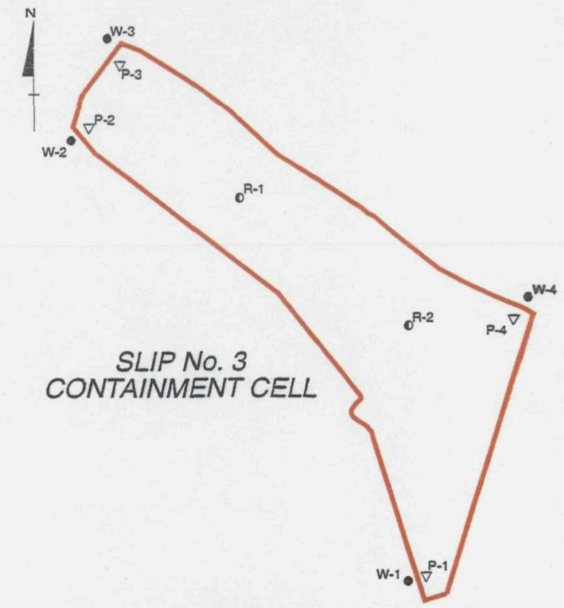
FIGURE 4





KEY PLAN

NOT TO SCALE

PUMPING TEST
SLIP No. 3 CONTAINMENT CELL
GROUND WATER ELEVATION vs. TIME
OCTOBER 20, 1993 THROUGH JUNE 1, 1995
WAUKEGAN HARBOR, WAUKEGAN, ILLINOIS

PREPARED FOR

WAUKEGAN HARBOR TRUST

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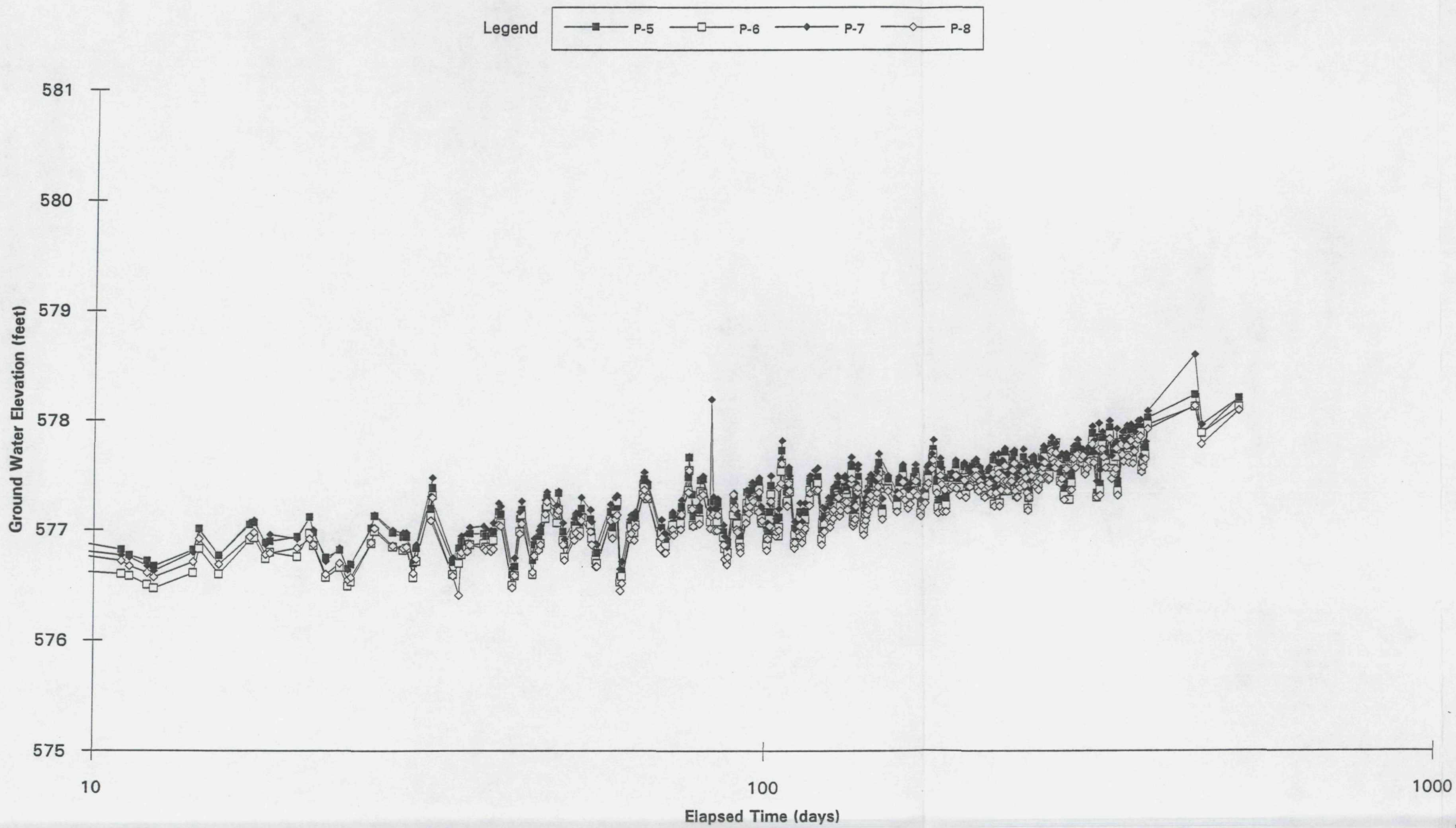
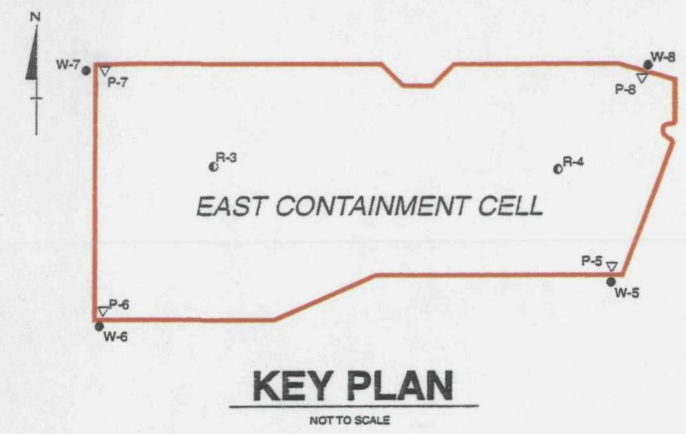
FIGURE 5





RECOVERY
EAST CONTAINMENT CELL
GROUND WATER ELEVATION vs. TIME
DECEMBER 27, 1993 THROUGH JUNE 1, 1995
WAUKEGAN HARBOR, WAUKEGAN, ILLINOIS

PREPARED FOR

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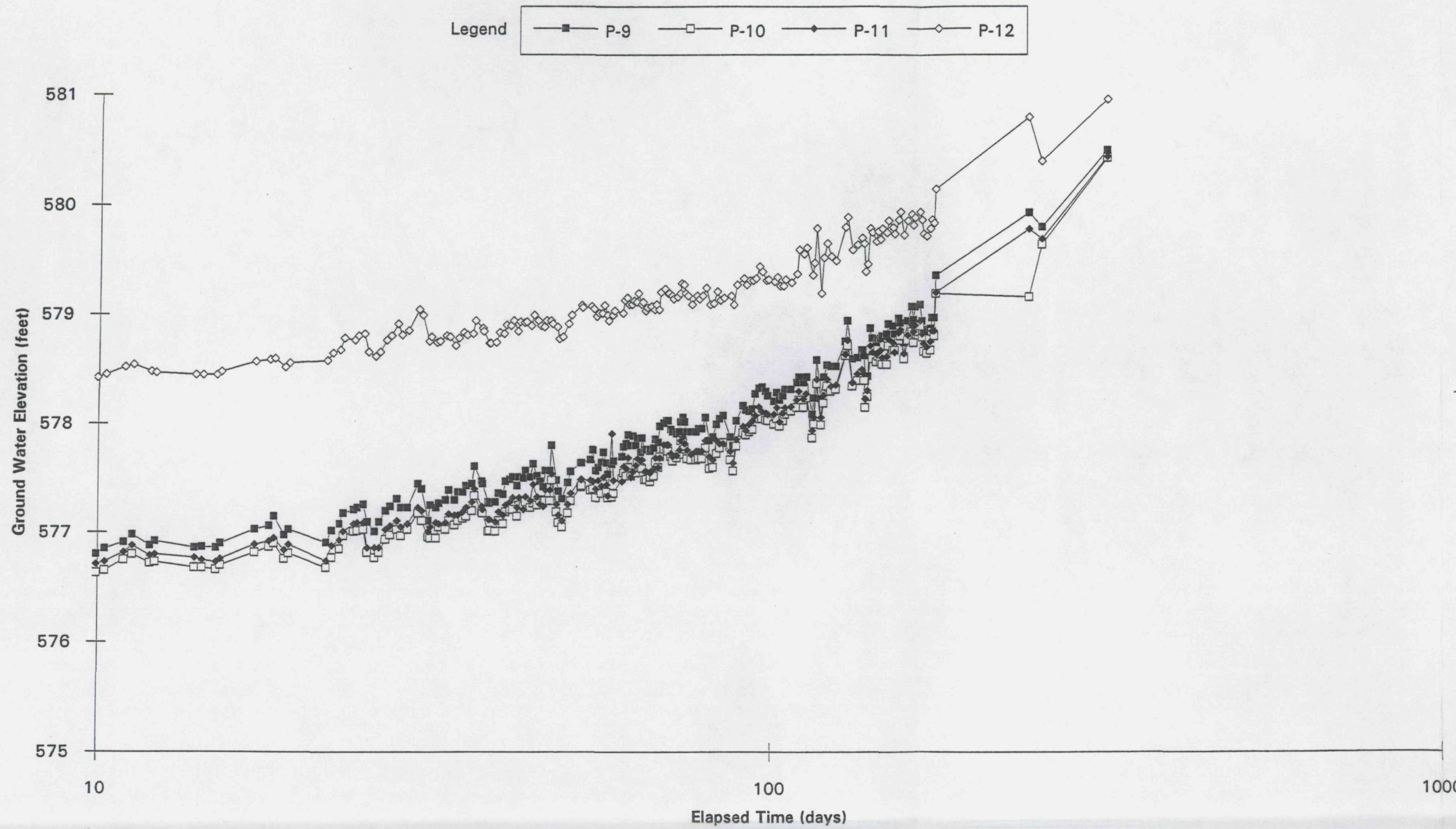
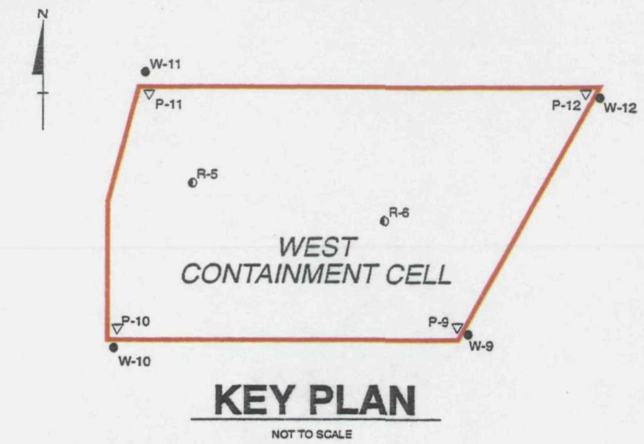
FIGURE 6





RECOVERY
WEST CONTAINMENT CELL
GROUND WATER ELEVATION vs. TIME
JULY 14, 1994 THROUGH JUNE 1, 1995
WAUKEGAN HARBOR, WAUKEGAN, ILLINOIS

PREPARED FOR

WAUKEGAN HARBOR TRUST

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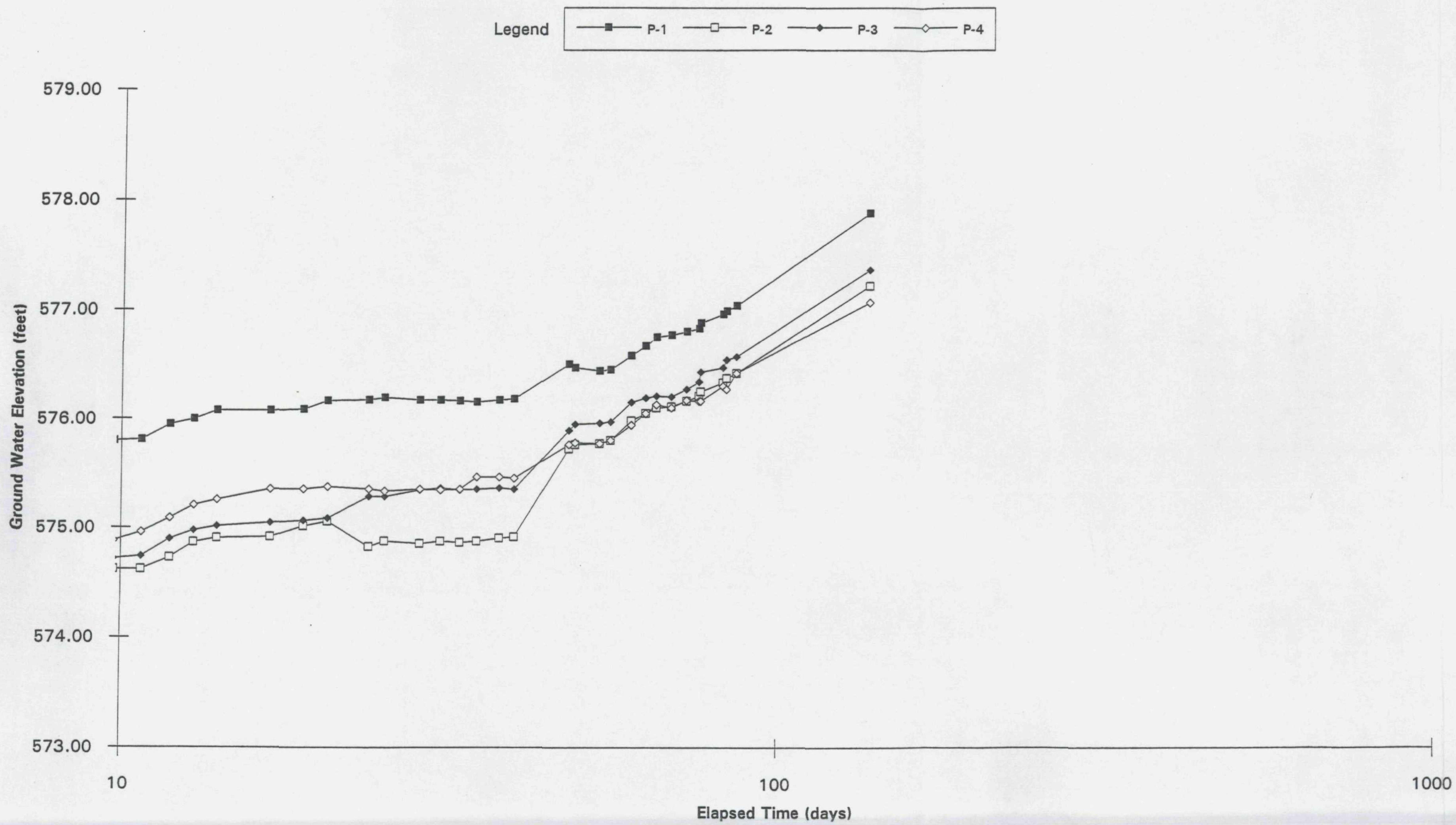
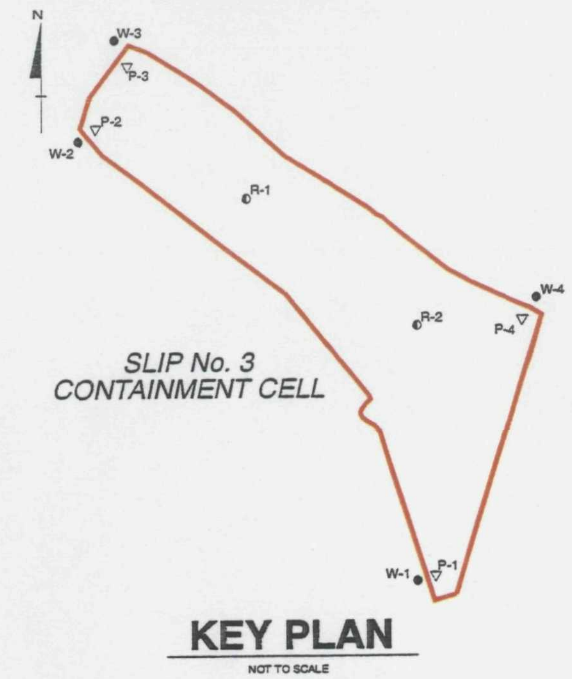
FIGURE 7





RECOVERY
SLIP No.3 CONTAINMENT CELL
GROUND WATER ELEVATION vs. TIME
JANUARY 6, 1995 THROUGH JUNE 1, 1995
WAUKEGAN HARBOR, WAUKEGAN, ILLINOIS

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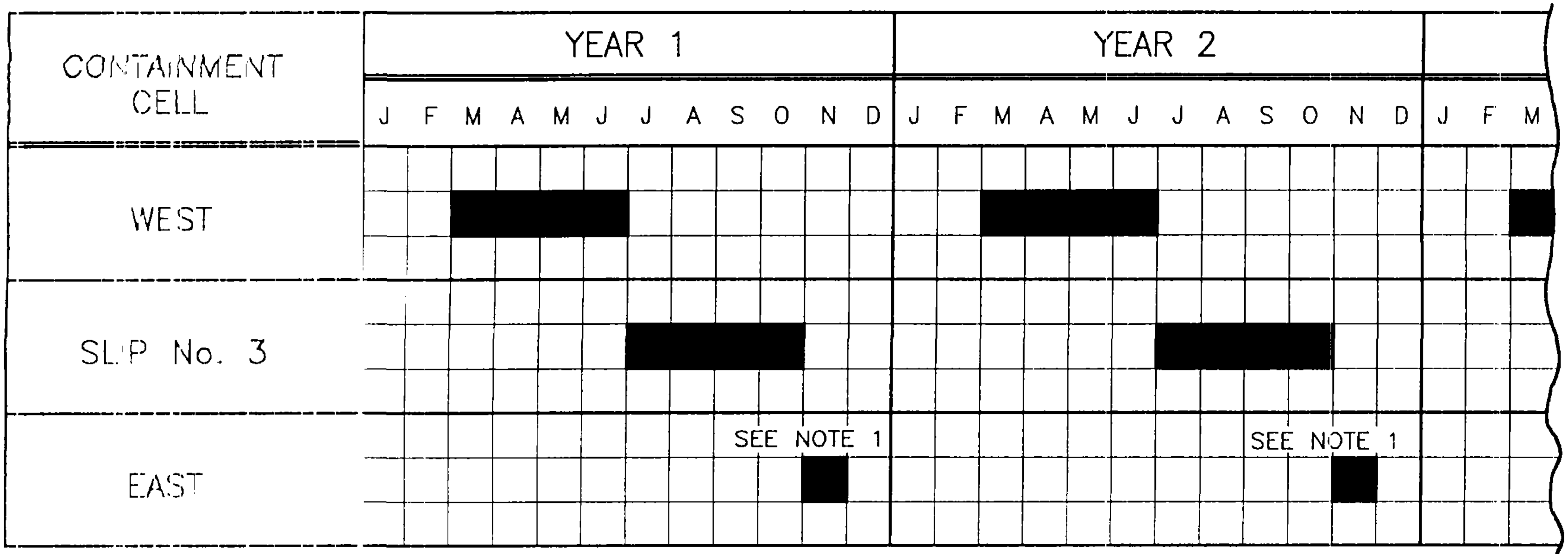
FIGURE 8

DRAWING NUMBER 87-126-A549



NOTES:

1. THE EAST CONTAINMENT CELL IS EXPECTED TO RECOVER TO LESS THAN 1 FOOT GRADIENT ACROSS THE SLURRY WALL IN NOT LESS THAN 4 YEARS. A GRADIENT GREATER THAN ONE FOOT CAN BE MAINTAINED BY PUMPING FOR ONE MONTH EVERY YEAR TO AVOID TREATING WATER DURING WINTER, OR PUMPED FOR 3 TO 4 MONTHS AS REQUIRED, ALTHOUGH THE PUMPING WOULD OCCUR DURING THE WINTER.

ANTICIPATED PUMPING SCHEDULE
WAUKEGAN HARBOR, WAUKEGAN, ILLINOIS

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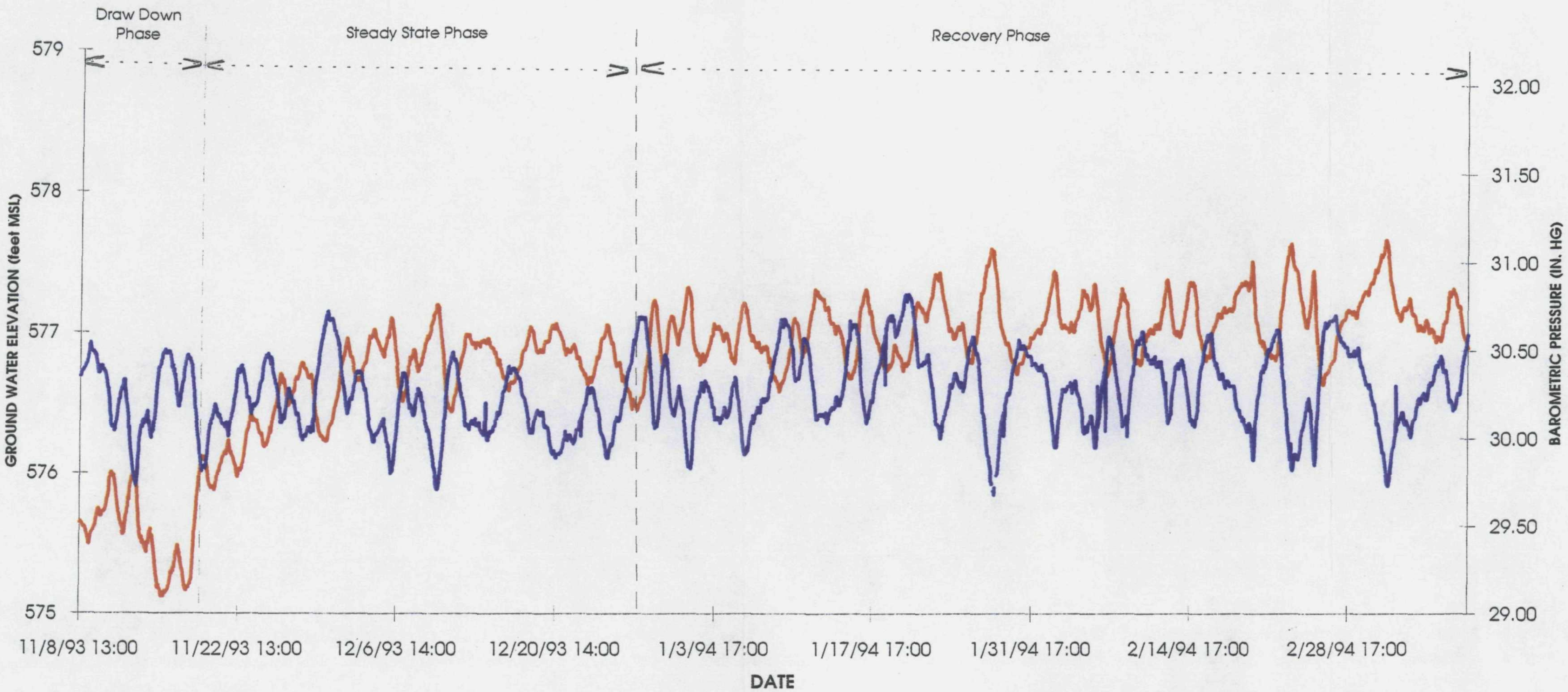
No.	DATE	ISSUE / REVISION	DWN BY	CK'D BY	AP'D BY
△			DJ		

DATE: 7-11-95 SCALE: NONE	FIGURE 9	DRAWING NUMBER 87-126-A549



DRAWING NUMBER 87-126-B550

LEGEND:

HERMIT 2000 DATA PIEZOMETER P-5

BAROMETRIC PRESSURE DATA

NOTES:

1. BAROMETRIC PRESSURE DATA WAS RECORDED AT THE OMC WEATHER STATION.

GROUND WATER ELEVATION P-5 AND BAROMETRIC PRESSURE DATA
11-8-93 THROUGH 3-19-94
EAST CONTAINMENT CELL
WAUKEGAN HARBOR, WAUKEGAN IllINOIS

PREPARED FOR

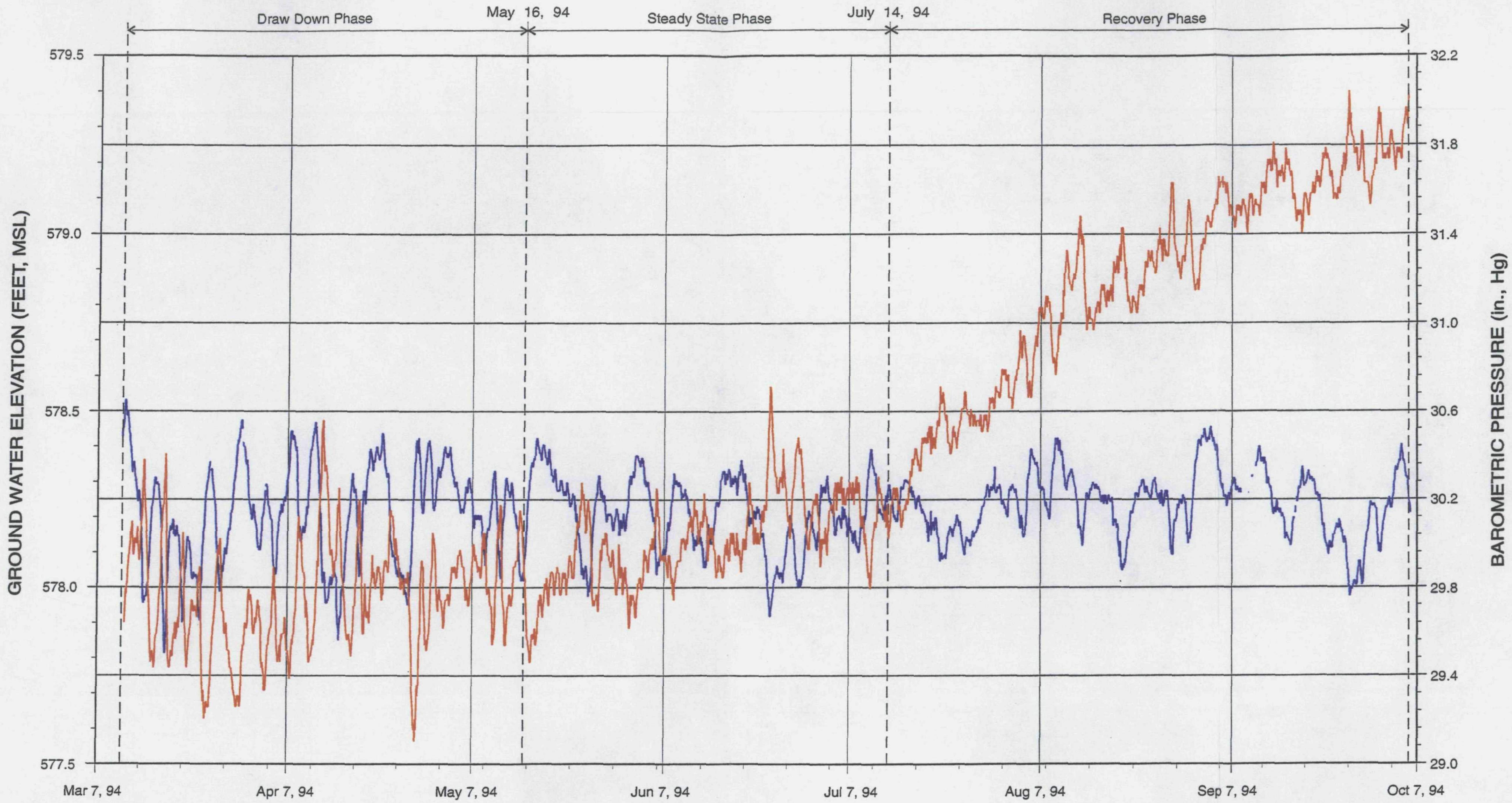
WAUKEGAN HARBOR TRUST

Canonie Environmental

No.	DATE	ISSUE / REVISION	DWN. BY	CK'D BY	AP'D BY
△			MAM		

DATE: 7-14-95	FIGURE 10	DRAWING NUMBER 87-126-B550
SCALE: NONE		

DRAWING NUMBER 87-126-B527



GROUND WATER ELEVATION P-12 AND
BAROMETRIC PRESSURE DATA
3-11-94 THROUGH 10-5-94
WEST CONTAINMENT CELL
WAUKEGAN HARBOR, WAUKEGAN IIIINOIS

PREPARED FOR

WAUKEGAN HARBOR TRUST

LEGEND:

HERMIT 2000 DATA PIEZOMETER P-12

BAROMETRIC PRESSURE DATA

NOTES:

1. BAROMETRIC PRESSURE DATA WAS RECORDED AT THE OMC WEATHER STATION.

△			SAK		
No.	DATE	ISSUE / REVISION	DWN. BY	CK'D BY	AP'D BY

Canonie Environmental

DATE: 11-23-94 SCALE: NONE	FIGURE 11	DRAWING NUMBER 87-126-B527